Lead

Douglas Dollhopf <dollhopf@montana.edu>

01/13/2003 08:13 AM
Please respond to dollhopf

To: Scott Brown/MO/R8/USEPA/US@EPA
cc: Dennis Neuman <dneuman@montana.edu>
Subject: Helena Valley Pb at 500

<<...>>

Dear Scott,

Attached is a statement pertaining to location of the isoline that exhibits soil Pb at 500 mg/kg at a specified probability. We can discuss this result at your earliest convenience.

Sincerely,

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- Helena Valley Kriged Map 500 Pb Area Tech Memo.wpd

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January 13, 2003

To: Mr. Scott Brown, U.S.E.P.A., Helena, MT.

From: Douglas J. Dollhopf

Cc: Dennis Neuman

Re: **Estimated Area In Helena Valley Where Total Soil Lead Concentrations Exceed 500 mg/kg.**

Objective

Identify the area in the Helena Valley where there is less than a 2.5 % probability that total soil lead concentration is greater than 500 mg/kg.

Technical Literature Used

CH2M Hill. 1987. Remedial investigation of soils, vegetation and livestock for the East Helena site (ASARCO), East Helena, Montana. U.S.E.P.A., Helena, MT., pages 3.46-3.52.

Calculation Procedure

Using geostatistics, a semivariogram and associated kriged maps (Figures 3.4 and 3.5, CH2M Hill 1987) were prepared that depicted soil lead across the Helena Valley for the 0-4 inch depth increment. The following calculation was developed to determine the area on this map where there is less than a 2.5 % probability that total soil lead concentration is greater than 500 mg/kg.

•On Figure 3.5, the area encompassed by the 2.7 ($\log_{10}$) line is composed almost entirely of soils having greater than 500 mg/kg total lead.

•Total soil lead concentrations greater than 500 mg/kg will be occasionally encountered outside the 2.7 isoline, but there is less than a 2.5 % probability of locating such soil concentrations outside the 2.23 ($\log_{10}$) isoline in Figure 3.5. The 2.23 isoline equates to a total soil lead concentration of 169 mg/kg. The calculation in support of this finding follows.

•t-value @ n = 158 @ 97.5 % confidence = 1.96
As shown on Figure 3.4, a standard error of 0.24 is appropriate to use for the soil area containing greater than 500 mg/kg Pb.

$2.23 + (0.24)(1.96) = 2.7$
$10^{2.7} = 501.6$ mg/kg Pb

Interpretation

In Figure 3.5, the isoline labeled 2.2 encompasses an area, approximately 4.5 by 4.5 miles, beyond which there is less than a 2.5 % probability of locating a soil concentration greater than 500 mg/kg.

This kriged map can be used to provide guidance on soil lead concentrations across the Helena Valley and to aid in design of field sampling efforts. Although statistical levels of confidence can be calculated for isolines shown on Figure 3.5, caution should be exercised when making an interpretation. This map was developed using a predictive model based on 158 soil samples across the Helena Valley. If decisions need to be based on exact boundaries of soil Pb concentrations, then soil sampling and associated laboratory analysis should be used to define these boundaries.

Lead 1000mg/kg isoline 2.5"

0100097

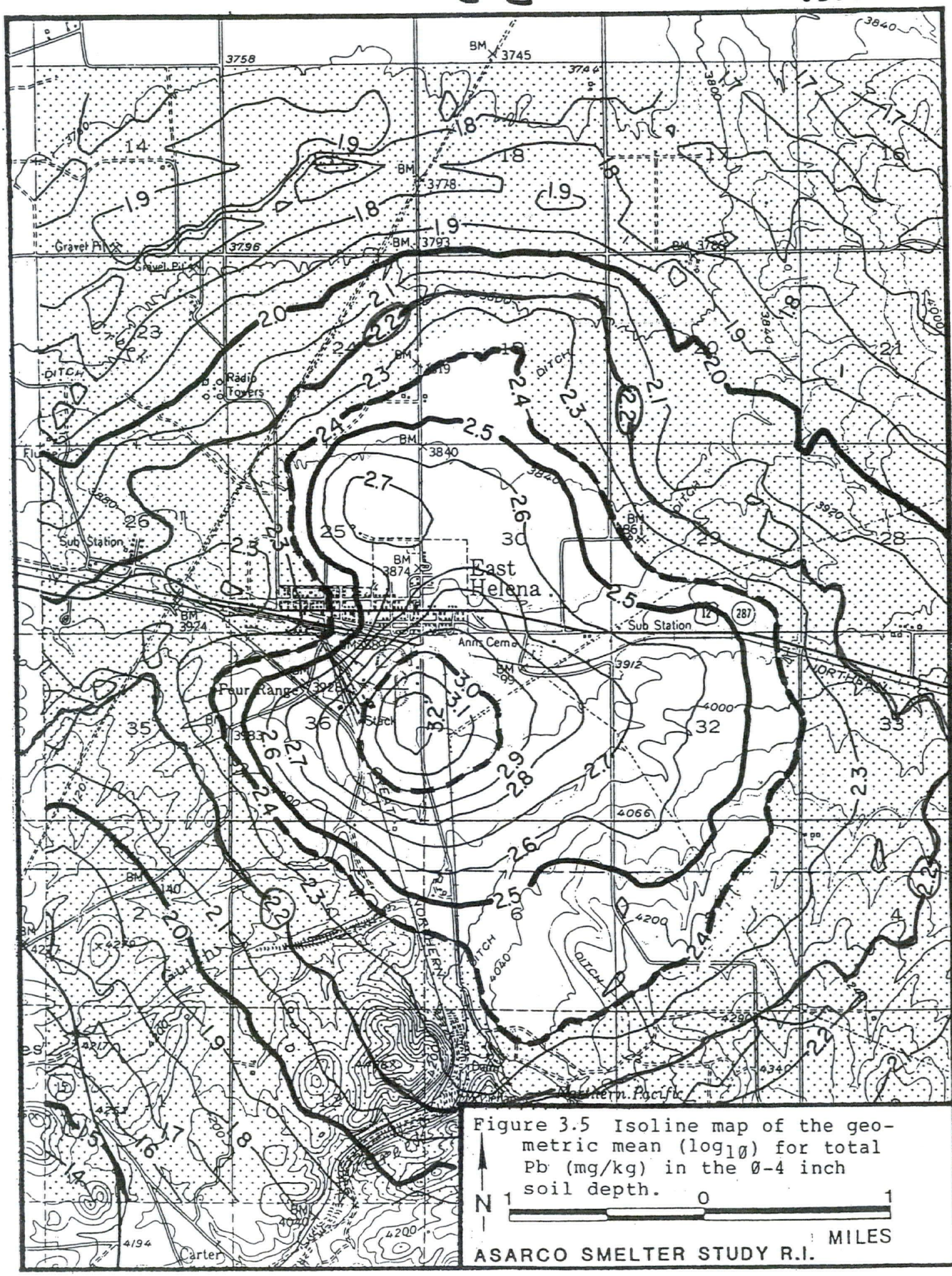

Figure 3.5 Isoline map of the geometric mean (log_{10}) for total Pb (mg/kg) in the 0-4 inch soil depth.

ASARCO SMELTER STUDY R.I.

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SPECIAL NOTE

Present in Figures 3.4-3.47 are pairs of isoline maps. Inorder to accurately align the standard error map (transparent) over the mean element concentration map, the 1.3 by 4.0 inch figure caption box needs to be in alignment for both maps. The scale for each map pair is the same.

To aid the reader, the map pocket at the end of this report (Appendix 9) contains a table that converts $\log_{10}$ values (mg/kg) to actual elemental concentrations (mg/kg). The map pocket also contains transparent overlays of both surface soil and core soil sample sites. These transparencies can be used to locate specific sample sites on the following isoline maps.

* *

3.8.2.2 Areal distribution of total soil Pb (0-4 inches)

Total soil Pb values for all 157 sampling sites are presented in Appendix 2. The areal distribution for these data are shown in Figures 3.3, 3.4 and 3.5.

As shown on Figure 3.3 a total Pb value of 12 mg/kg ($\log_{10}$ = 1.08) was used as the background level. The extent of soil Pb enrichment in the Helena Valley was represented by approximately 95% of the project area being above background. Mountainous areas adjacent to the Helena Valley seemed to be the only areas exempt from enrichment. A most probable Pb point source was clearly identified by concentric isolines of increasing Pb value near East Helena (Figure 3.5).

The current area identified as 1000 ppm Pb by the 3 (10^3 = 1000 mg/kg) isoline (Figure 3.5) was 0.4 square miles. Using the soil Pb standard error map (Figure 3.4) it was determined that 0.24 was an appropriate error for the greater than 1000 ppm area. The following calculation shows the upper and lower limits of the 3 (10^3 = 1000 mg/kg) isoline at 90% confidence.

Student's t-value @ n = 156 @ 90% confidence = 1.645
Upper limit is 3 + (0.24)(1.645) = 3.3948
$10^{3.3948}$ = 2,482 mg/kg
Lower limits is 3 - (.24)(1.645) = 2.605
$10^{2.605}$ = 402.9 mg/kg

Therefore it can be stated with a 90% confidence that soil total Pb values on the 1000 mg/kg isoline will range between 2,482 mg/kg and 402.9 mg/kg. This range 2,482 mg/kg to 402.9 mg/kg, may seem large, however the actual distance represented by the interval on the map (Figure 3.5) is small. For example, a line delineating the area (Figure 3.5) past which the probability of finding a 1000 mg/kg site is less than 2.5 percent is represented by isoline 2.5 ($10^{2.5}$ = 316 mg/kg). The following calculation shows why this line was chosen.

Student's t-value @ n = 158 @ 97.5% confidence = 1.96
2.5 + (0.24)(1.96) = 2.97
$10^{2.97}$ = 934.11 mg/kg

In summary, a review of the total soil Pb concentrations (Appendix 2) indicates the area encompassed by the 1000 mg/kg isoline (Figure 3.5) is composed almost entirely of soils containing greater than 1000 mg/kg Pb. Levels above this concentration were occasionally measured outside the 1000 mg/kg isoline, but there is a less than 2.5% probability of locating them beyond the 2.5 isoline.

3.8.2.3 Areal distribution of total soil As (0-4 inches).

Total soil As values for all 157 sampling sites are presented in Appendix 2. The areal distribution for these data are shown in Figures 3.6, 3.7 and 3.8.

As shown on Figure 3.6 a total As value of 16 mg/kg ($\log_{10}$ = 1.2) was used as the Helena Valley background level. The extent of soil As enrichment in the Helena Valley covered nearly the entire area. An area north of lake Helena was, however, near or below background. A most probable As point source was clearly identified by concentric isolines of increasing As value near East Helena (Figure 3.8).

The current area identified as greater than 100 ppm As by the 2 (10^2 = 100 mg/kg) isoline (Figure 3.8) was 0.8 square